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ELECTRICITY PRICES AND THE POOR: WHAT ARE THE EFFECTS AND WHAT --ETC(U)
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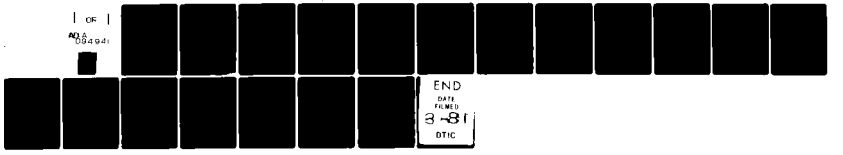

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(10) Jan Paul Acton

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ELECTRICITY PRICES AND THE POOR: WHAT ARE THE EFFECTS AND WHAT CAN WE DO?

The early 1970s marked the beginning of a new era for energy in the United States. It is now clearly evident that energy is no longer abundantly available at low prices and without interruption. Even in the absence of additional problems of supply from the mid-East, most analysts agree that future supplies of coal, oil, gas, and electricity will be forthcoming only at prices that are notably higher than in the past.

These price changes have already had an important effect on residential use of electricity and the bills people pay. Without meaning to downplay the impact on nonresidential customers, I would like to focus particularly on the effects of prices on residential users and to further concentrate on electricity use.

Over the period 1973-1978, the average price of electricity to residential users rose 69 percent nationwide. During the same period, the consumer price index rose 47 percent and disposable personal income rose 62 percent. So we can see that electricity prices rose faster than prices in general and income did not keep pace with the increase.

It is particularly appropriate to look at pricing effects in a conference devoted to energy and the poor. First, because prices

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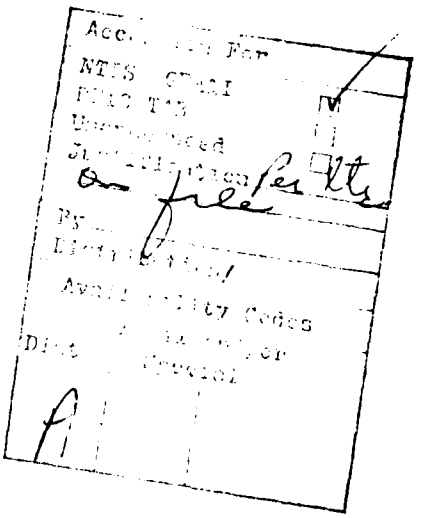
Delivered to a symposium, The Impact of Energy Prices on Low Income Populations, sponsored by the United States Community Services Administration, Berkelev, February 28-29, 1980. This paper draws extensively on two related Rand papers by Acton, Mitchell, and Sohlberg (1980) and Sullivan (1979). The analysis reported in those papers was supported by the Los Angeles Department of Water & Power and the National Science Foundation. The opinions expressed are the author's and do not necessarily reflect the opinion of any of Rand's sponsors.

affect the poor by reducing their income available for other uses. Second, because we wish to know if the impact on the poor is greater, the same, or less severe than on other categories of users.

We are also led to look at the linkages between energy prices and the poor because prices can be a potent policy tool. By changing the price of energy to some or all customers, we can help or hinder the economic condition of the poor. At the same time, correctly set prices can be one of the most important ingredients of a sound national policy towards present and future energy use. Prices that reflect the full social cost of energy resources can help assure future supplies of all forms of energy and they can help assure that consumers do not waste energy by using it under circumstances when they value it less than it costs to produce.

But now we are abruptly against an important policy question: Do we have two laudable goals which are fundamentally inconsistent with one another? Is it possible to blunt the impact of rapidly rising energy prices on some of the customers without subverting the goals of prudent use in the long term? To answer this question we must step back and look at fundamental empirical evidence of the relationship between prices and the use of electricity; that is the subject of the first section. Second, we look especially at the evidence of differential impact by level of use or level of income. Finally, we will review in particular an electricity lifeline rate that was adopted in Los Angeles and evaluate it against these two social objectives of efficiency and improved well-being of lower income individuals.

Without intending to give away the plot, I will tell you at the outset that there will be some pleasant surprises. Our analysis indicates that, at least under some circumstances, public policies can be designed to help the poor through the pricing mechanism without destroying the efficiency gains that are generally found with market prices that reflect the full costs of production and supply.



I. PRICES AND CONSUMPTION

It is useful to have a model of energy use in mind when we analyze pricing effects.[1] People do not consume electricity, coal, natural gas, or oil for themselves but rather for the services that they provide such as heating, cooling, or lighting. Electricity and other forms of energy must be used in combination with appliances to produce the desired services. Although they are economically interdependent decisions, it is useful to think of the consumer's decisions as falling into three parts: First, he or she decides whether or not to have an energy-using appliance to perform a particular service (e.g., cooking). Second, the customer decides which fuel (e.g., gas or electricity) and perhaps the size of the appliance (e.g., rated capacity of an air conditioner or a frost-free feature on a refrigerator). Third, once the appliance is owned and in place, the consumer decides how often and how intensively he uses the appliance.

The important thing from the point of view of understanding the empirical evidence and in evaluating public policies is that these decisions are made over very different time horizons. The intensity of use decision can be made on an hour by hour or month to month basis and therefore can be adjusted rapidly to changes in prices. The ownership and fuel type of appliances are decisions made over a matter of years and will not change abruptly for most individuals even when the prices of alternative forms of energy change dramatically.

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[1] I do not propose to develop the model at this point. The interested reader should consult Acton, Mitchell, & Sohlberg (1980) for a more complete discussion.

When we employ a model of demand that incorporates these features of appliance choice and intensity of use, we find a statistically significant effect of price on the amount of electricity consumed. In our analysis of household electricity use in Los Angeles County, we employed detailed data that includes extensive information about climate and holdings of 16 different appliances, as well as demographic information regarding income, family size, and ages of members of the household. In analysis covering the period 1972-1974, we found short run elasticities[1] of demand with respect to price of electricity between -.20 and -.53 and centered around -.35. Longer run elasticities, which reflect aspects of long term change in appliance ownership, average -.70 to -.74.[2]

Other analysis of electricity use in the city of Los Angeles over the period 1975-1976 has confirmed these basic findings when estimated over individual household data. Sullivan (1979) finds elasticities with respect to price of electricity ranging between -.16 and -.23 for a specification similar to Acton, Mitchell, and Sohlberg's. He finds smaller (closer to 0) elasticities when he estimates demand among low income senior citizen households, which is discussed more fully in the next subsection.

The results of these two studies are consistent with several other findings of a statistically significant relationship between

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[1]The elasticity of demand is defined as the percentage change quantity divided by percentage change in price and is independent of the units in which electricity or price is measured.

[2]See Acton, Mitchell, and Sohlberg (1980) for these empirical results and Acton, Mitchell, and Mowill (1976) for a detailed presentation of the data and results of alternative specifications.

electricity prices and consumption. These Los Angeles results tend to be similar or smaller in magnitude than many others that are reported. For example, Taylor's (1975) survey and other recent literature[1] found residential price elasticities ranging from -.14 to -.90 in the short run and -1.00 to -2.00 in the long run. In our analysis (Acton, Mitchell, Sohlberg, 1980) of the econometrics of the electricity demand, we find reason to suspect that the majority of these studies have coefficients which are biased away from 0 (implying greater responsiveness to price than is actually there), especially for these long run estimates.

[1] In addition to references in Taylor, see McFadden, Puig, and Kirschner (1977), Ruffell (1978), and Wilder and Willenborg (1975).

II. CONSUMPTION, PRICES, AND THE POOR

The relationship between income and level of electricity use in Los Angeles is shown in Table 1. Broadly speaking, there is a positive correlation between income and monthly consumption. Over 70% of households with annual income below $7,500 per year consume less than 200 kwh per month. This compares with a systemwide average of almost 400 kwh/month in L.A. Only 17% of households with income above $15,000 consume less than 200 kwh per month and 15% of such households consume over 1,000 kwh per month on average. The correlation is not perfect, of course. A significant number of low income households consume higher amounts of electricity and many higher income households use relatively modest amounts of electricity. Careful statistical analysis is needed to separate the effects of income from other factors on overall electricity use.

Both the Acton, Mitchell, and Sohlberg and the Sullivan studies in Los Angeles permit us to examine the relationship between energy use and income as well as appliance ownership. Because detailed and extensive data files are used, we have the information which permits estimating the effects of differing appliance ownership and a sufficient number of observations to estimate the relationships. Both studies find a statistically significant elasticity with respect to income ranging between .05 and .08 in Sullivan and .31 and .41 in Acton, Mitchell, Sohlberg. The short run and long run income elasticities reported in Taylor's survey and other studied cited above fall over a considerably wider range and may be subject to the same econometric criticism as some of the pricing results discussed in the previous section.

Table 1

PERCENT OF RESIDENTIAL CUSTOMERS BY INCOME AND LEVEL OF ELECTRICITY USE

Income	kwh/month			
	0-200	201-500	501-1,000	1,000 +
$0-$7,500	20.5	7.2	1.1	.1
$7,501-$15,000	15.4	11.4	2.7	.2
$15,001 +	7.1	17.4	10.5	6.4

SOURCE: Calculated from Sullivan (1979, Appendix B).

We suspect that much of the effect of income on electricity use is reflected in the longer term decisions about appliance holdings--as well as size and type of dwelling. In general, there is a positive correlation between level of income and aggregate appliance holdings, although the relationship is not perfect. Some lower income households have extensive appliance holdings and some higher income households have modest holdings of electricity appliances. In order to capture these effects, the Acton, Mitchell, and Sohlberg analysis allowed the amount of appliance holdings to directly affect the predicted responsiveness to price. The price elasticities reported in the last section were evaluated at the mean appliance holdings for the entire population. When we allow for the more modest appliance holdings of higher level users, we find notable variation in the predicted price responsiveness.

Table 2 gives elasticities calculated at three levels of use in the Los Angeles system. The different levels of assumed appliance holdings lead to predictions that customers will be about one half as price responsive at the lowest levels of use than at upper levels of use.

Sullivan estimates separate demand equations for two subpopulations of residential customers in the Los Angeles Department of Water & Power service territory. One subpopulation was later enrolled on a lifeline rate made available to low income (under $7500 per year) senior citizens and the other subpopulation consisted of all other residential users. Using a survey of some 2,096 households, during which extensive demographic and appliance data were collected, Sullivan estimates the price elasticity of demand for lifeline household to be -.16 in a period before the rate was introduced. For nonlifeline households, he found a price elasticity of about -.23. Sullivan also examined the patterns of elasticity use before and after lifeline rates were introduced for a

Table 2

ESTIMATED PRICE ELASTICITIES OF DEMAND BY LEVEL OF RESIDENTIAL ELECTRICITY USE IN LOS ANGELES

	1	2	3	4	TOTAL
Range of Consumption (kwh/month)	0-100	151-400	401-1,000	1,000 +	
Mean Consumption (kwh/month)	92	264	593	1,533	387
Estimated Price Elasticity	-.25	-.35	-.44	--[a]	-.35

[a]Not estimated due to variability in appliance holdings.

Source: Acton, Mitchell, and Sohlberg (1980, Tables 2 and 3).

sample of households. Adjusting for weather effects between the two years, he found that price elasticities ranged from -.07 to -.14 in four areas of the city.

These smaller (closer tc 0) elasticities mean that households with modest appliance holdings and households headed by low income senior citizens will demonstrate less adjustment, proportionately, to changes in price than other customers. If a price rise occurs, households will reduce their usage very little, and instead will have that much less money left over for consuming other goods. Conversely, a price fall will lead relatively little increased electricity use and will amount to extra dollars available for other uses.

III. THE LOS ANGELES SENIOR CITIZEN LIFELINE RATE

The empirical results just reviewed have important implications for a public policy that attempts to assist the poor and still meet goals of efficiency in energy use. When customers are highly responsive to price, a deliberate subsidy, or underpricing, of electricity will lead to significant increases in use and--if the subsidized price lies below the full (marginal) cost of production--will lead to some waste in electricity use. If, on the other hand, customers are very unresponsive to price (highly price inelastic), then lowering the price will result in very little increased use--very little consumption which the customer values less than the marginal cost of production. Consequently, a subsidy that is applied to a price inelastic good acts mainly like an income transfer and induces very little waste or efficiency loss. The empirical results presented above suggest that two groups of households are below average in their price responsiveness (and relatively close to 0 in any case): households with modest holdings of electrical appliances and households headed by low income senior citizens.

The Los Angeles senior citizen lifeline rate took advantage of this empirical relationship to blunt the impact of rapidly rising electricity prices in 1975. After considering a variety of alternatives which included an energy stamp and a universal lifeline rate applied to all residential customers, the city adopted a plan which gave a 50 percent discount on the first 180 kilowatt hours per month. The lifeline discount was made available to households headed by a senior citizen

(over 62) with combined family income less than $7500 per year. Based on census information, the city estimated that 110,000 households would meet this criterion, although some fraction would live in apartments or other dwellings that had master metering and therefore would not be able to take advantage of the rate.

The Los Angeles plan went into effect in November 1975. In the previous summer, the city council had exempted low income senior citizens from the city's 5 percent utility tax (covering electricity, gas, water, and telephone). The lifeline rate employed the same mechanism for enrollment as the utility tax exemption--a signed declaration that included social security number. Whereas only a fraction of eligible households took advantage of the 5 percent tax exemption (59,000 had enrolled prior to November 1975), a substantial number of additional customers enrolled when the utility bill was reduced by the 50 percent amount for the first block of consumption. At the time the rate was introduced, the 50 percent discount was worth about $3 per month to a household consuming over 180 kilowatt hours a month and within a year of enactment, about 90,000 households were paying for electricity on the lifeline rate. The widespread enrollment was aided by senior citizen groups who went to senior citizen centers and actively promoted the enrollment.

Administrative costs were modest to the city, especially as compared with the recurring costs of an ongoing program such as energy stamps. City clerks were used to process the forms at an estimated $4 per households. In addition, the Department of Water

& Power spent approximately $9,000 to adjust its billing procedures to accommodate the new rate.

The Los Angeles plan was financed by raising the bills of all other residential, commercial, and industrial customers by 1.8 percent. Because higher volume residential users (with their greater appliance holdings, etc.) are estimated to be more price responsive, we have an interesting conclusion from the Los Angeles experience. As shown in Table 3, Sullivan estimates that 33,000 of the lifeline households each increased their use by some 6.5 kwh per month (after adjusting for weather), due to the 50 percent discount on their first 180 kilowatt hours of use each month, while the remaining lifeline customers and some 900,000 nonlifeline customers reduced their use about 3 kilowatt hours on average in response to their 1.8 percent higher bills. In net, it appears that residential use in Los Angeles actually went down as a result of the lifeline rate because of the greater price responsiveness of higher volume users and their large number.

Table 3

ESTIMATED EFFECTS ON RESIDENTIAL ELECTRICITY USE
FROM INTRODUCING LIFE RATES

	Number[a]	Mean Charge in Monthly Use per Customer (kwh)	Monthly Change in Residential Use (kwh)
Lifeline Customers			
Consuming ≤ 180 kwh/mo.	33,000	+6.5	+214,500
Consuming > 180 kwh/mo.	56,000	-3	-168,000
Non-lifeline Customers	900,000	-3	-2,700,000

Note: Further effects are probably realized from reduced consumption by commercial and industrial customers, which is not included in these calculations.

[a]Approximate numbers at the end of the first year lifeline rates were in effect.

Source: Sullivan (1979).

IV. CONCLUSION

Analysis of the Los Angeles experience with electricity use can be instructive for evaluating efforts to ease the burden of price rises on lower income households. First, the empirical analysis of electricity demand demonstrates that residential customers are sensitive to the price of electricity, but the effects are not uniform. Customers with lower incomes, more modest holdings of appliances, and lower use in general are less responsive to price changes than are customers with higher incomes, greater appliance holdings, and higher levels of use. This means that when price rises, it acts like a tax on lower level users who demonstrate little shift in their usage--at least in the short run--and instead face higher bills. This lowered price responsiveness also indicates that subsidizing the price of electricity to such households will act mainly like an income transfer and will freeup income for other uses.

The Los Angeles Senior Citizen Lifeline rate was an attempt to ease the impact of rapidly rising electricity prices on a particular group of customers. First, the eligibility was limited to lower income senior citizens in order to concentrate the benefits on those felt to be most needy. A broader criterion of eligibility--for instance, all low level users--would have been considerably more costly and would have given benefits to a considerable number of customers at higher income levels. Second, the Los Angeles Senior Citizen Lifeline rate applied its price reductions at the lower level of use each month. This also permitted benefits to be concentrated.

And, because the customers are less price responsive at lower levels of use, it also allowed the Los Angeles electricity rate structure to signal the more correct costs of energy to those customers who are most sensitive to its price--including those lifeline customers consuming over 180 kilowatt hours per month. In so doing, it promotes economic efficiency and nonwastage of energy resources.

The Los Angeles lifeline rate is instructive in its implementation. By choosing a relatively simple criterion of elibility, enrollment and administrative costs were kept low. By choosing a simple means of distributing the benefit--changing customer's bills--the ongoing costs of program administration are negligible. Some of the alternatives that were considered and rejected included energy stamps which would have been much more costly to initiate and to run.

Finally, the Los Angeles rate was a success in reaching the majority of the households it attempted to reach. Of the estimated 110,000 potentially eligible households, over 90,000 had enrolled by the end of the first year. Los Angeles rate officials estimate that most of the remaining customers are in master metered units that are not eligible for the rate discount. The majority of customers are receiving a benefit that is now worth over $5 per month per customer and that benefit automatically keeps up with the inflation and electricity prices.

REFERENCES

Acton, Jan Paul, Bridger M. Mitchell, and Ragnhild Sohlberg Mowill (1976). Residential Demand for Electricity in Los Angeles: An Econometric Study of Disaggregated Data, R-1899-NSF. Santa Monica: Rand Corp.

Acton, Jan Paul, Bridger M. Mitchell, and Ragnhild Sohlberg (1980). "Estimating Residential Electricity Demand Under Declining-Block Tariffs: An Econometric Study Using Micro-Data," in Applied Economics, Vol. 12, No. 1 (March).

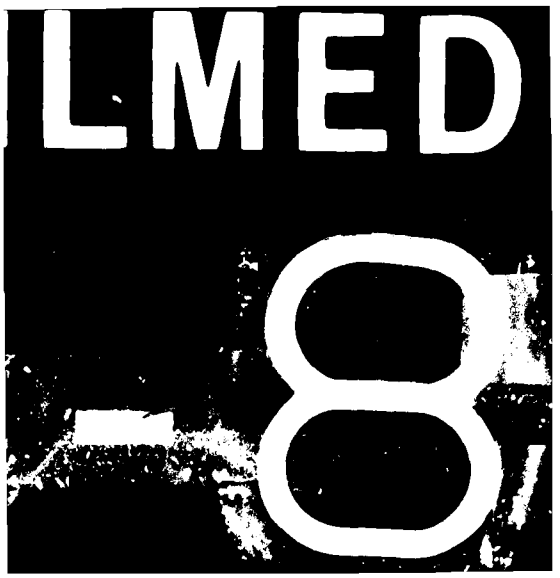
McFadden, D., Puig, C. and Kirschner, D. (1977). Determinants of the Long-Run Demand for Electricity, Cambridge Systematics working paper.

Sullivan, Timothy J. (1979). The Los Angeles Senior Citizen Lifeline Electricity Rate, R-2278-DWP/NSF. Santa Monica: The Rand Corp.

Ruffell, R. J. (1978). Measurement of Own-Price Effects on the Household Demand for Electricity, Applied Economics, 10, 21-30.

Taylor, Lester D. (1975). "The Demand for Electricity: a Survey" in Bell Journal of Economics, Vol. 6, No. 1 (Spring) pp. 74-110.

Wilder, R. P., and Willenborg, J. F. (1975). Residential Demand for Electricity: A Consumer Panel Approach, Southern Economic Journal, October. pp. 212-217.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